Small Business Innovation Research/Small Business Tech Transfer

An Intelligent Framework to Develop Adaptive Parametric Reduced Order Model Database for Aerostructural Control, Phase I

Completed Technology Project (2018 - 2019)

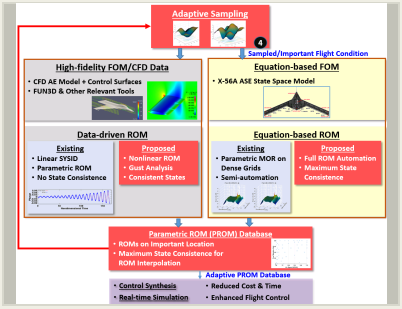
Project Introduction

The goal of the project is to develop an intelligent framework to construct adaptive parametric reduced order model (PROM) database for aeroservoelastic (ASE) analysis and aerostructural control. Leveraging on significant advancements by the proposing team in prior research, this Phase I effort will initiate a new frontier of 'engineering intelligence' to further ASE ROM development, including several emerging techniques: genetic algorithm optimization-guided ROMs, data-driven ROM for nonlinear aeroelasticity and gust response analysis, online determination of critical flight conditions and *in-situ* PROM database development while modeling, CFD computation, and ROM are in progress. A modular software framework will be established for automated PROM generation and optimization, consistent state enforcement, adaptive parameter space sampling, and database population. The feasibility of the proposed technology will be demonstrated for ASE problems of NASA interest (e.g., High-speed ASE, X-56A MUTT, etc.). The Phase II effort will focus on: (1) PROM engine optimization in terms of execution efficiency, robustness, and autonomy; and (2) direct integration of the 'intelligent' environment into NASA workflow; and process automation of modeling, simulation, and control synthesis for technology insertion and transition; and (3) extensive software validation and demonstration for ASE and flight control analysis of realistic aircrafts of current NASA interest

Anticipated Benefits

The developed technology will enable NASA to (1) determine critical flight conditions and guide CFD/ASE computation and flight testing; (2) enable real-time ASE simulation and flight control synthesis, and (3) develop advanced aerostructural control strategies. It will markedly reduce development costs and cycles of aerospace vehicles. NASA projects like High Speed ASE, MUTT, and MADCAT will benefit from the technology.

The non-NASA applications are vast, and will focus on aerospace, aircraft, and watercraft engineering for fluid-structural interaction and fatigue analysis, real-time flow control and optimization, hardware-in-loop simulation, and others. The proposed development would provide a powerful tool to generate fast ROMs, which can be used for (1) fault diagnostics and optimized design; (2) design and planning of simulations and experiments, and (2) development of advanced control strategies.



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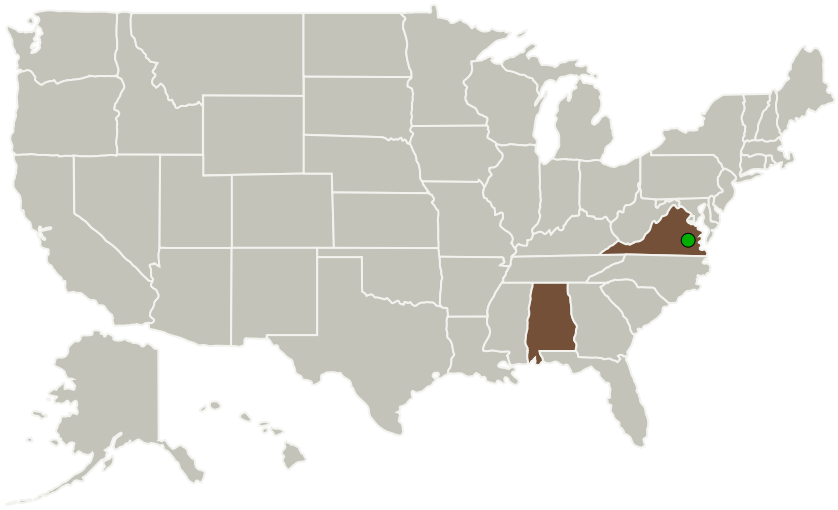
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
CFD Research Corporation	Lead Organization	Industry	Huntsville, Alabama
Langley Research Center(LaRC)	Supporting Organization	NASA Center	Hampton, Virginia

Primary U.S. Work Locations	
Alabama	Virginia

Project Transitions

July 2018: Project Start

February 2019: Closed out

Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/140929)*

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

CFD Research Corporation

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

Carlos Torrez

Principal Investigator:

Kapil Pant

Co-Investigator:

Kapil Pant

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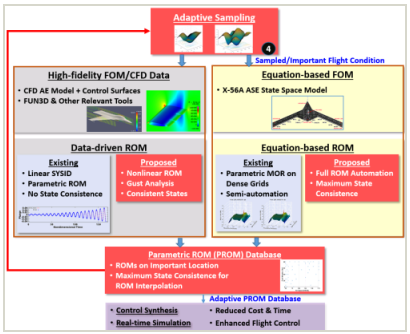
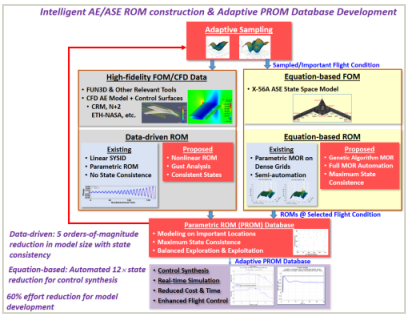
Images



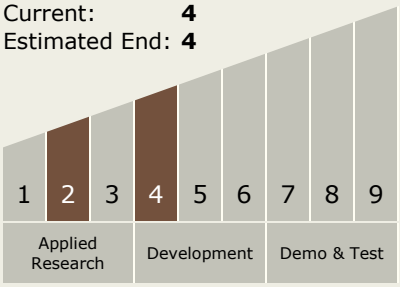
Briefing Chart Image
An Intelligent Framework to Develop Adaptive Parametric Reduced Order Model Database for Aerostructural Control, Phase I *(https://techport.nasa.gov/image/130268)*



Final Summary Chart Image
An Intelligent Framework to Develop Adaptive Parametric Reduced Order Model Database for Aerostructural Control, Phase I *(https://techport.nasa.gov/image/136165)*

Technology Maturity (TRL)

Start: **2**
Current: **4**
Estimated End: **4**



Technology Areas

Primary:

- TX11 Software, Modeling, Simulation, and Information Processing
  - TX11.4 Information Processing
    - TX11.4.4 Collaborative Science and Engineering

Target Destination

Earth